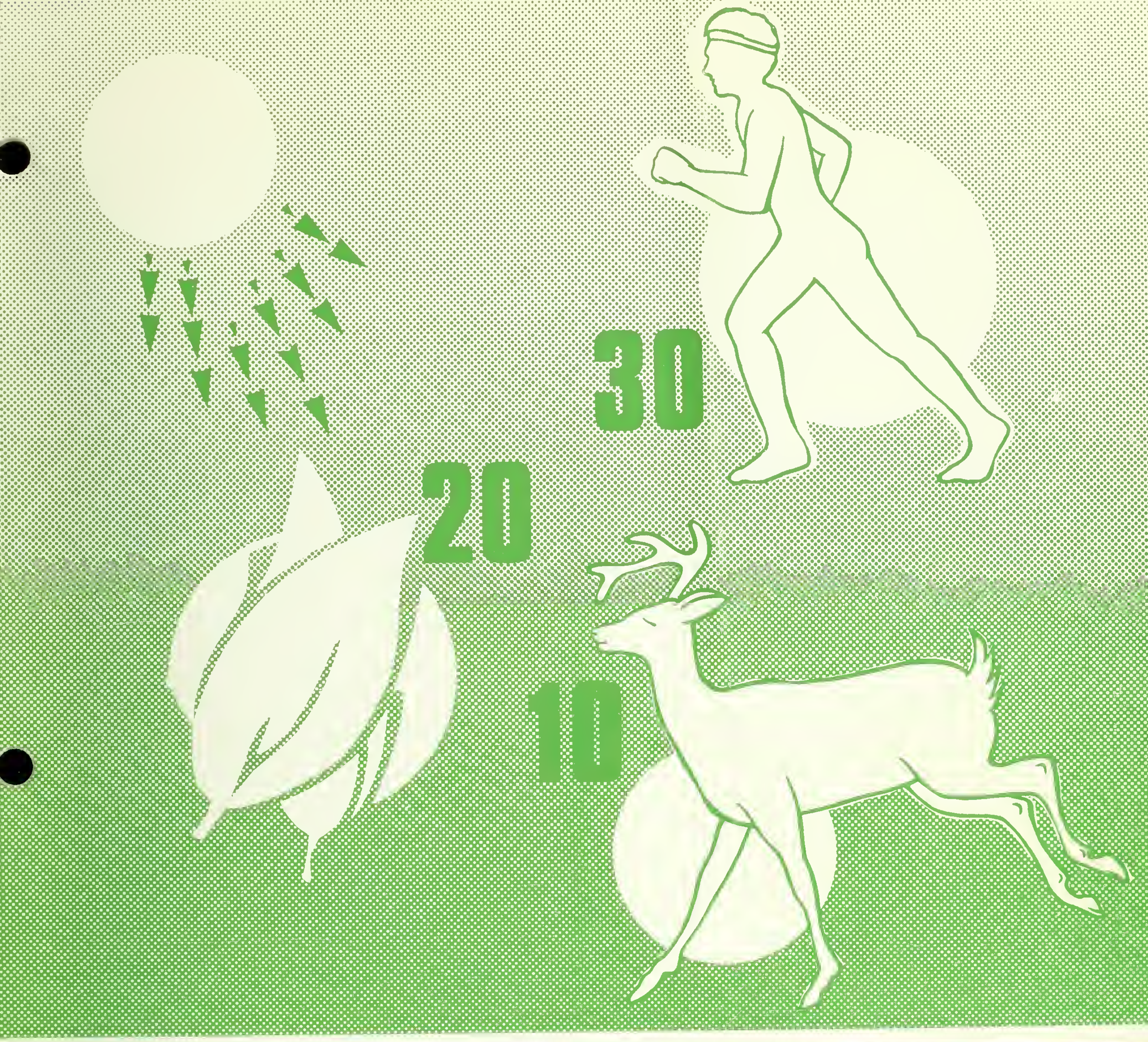

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# BIOLOGY
# 10 - 20 - 30

CURRICULUM GUIDE 1984

# ACKNOWLEDGEMENT

Alberta Education acknowledges with appreciation the contribution of the Biology Ad Hoc Curriculum Committee members in the preparation of this curriculum guide for senior high school biology. The committee operated under the direction of the Science Curriculum Coordinating Committee and the Curriculum Policies Committee.

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NOTE: This publication is a service document. The advice and direction offered is suggestive except where it duplicates or paraphrases the contents of the Program of Studies. In these instances, the content is color coded in the same distinctive manner as this notice so that the reader may readily identify all prescriptive statements or segments of the document.

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# TABLE OF CONTENTS

Page

PHILOSOPHY . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1

GENERAL OBJECTIVES FOR SCIENCE EDUCATION . . . . . . . . . . . . . . . . . 2

PROGRAM STRUCTURE AND ORGANIZATION . . . . . . . . . . . . . . . . . . . 3

- Program Elements . . . . . . . . . . . . . . . . . . . . . . . 5
- Core-Elective Format . . . . . . . . . . . . . . . . . . . . . 6
- Credit Structure . . . . . . . . . . . . . . . . . . . . . . . 6
- Program Specificity . . . . . . . . . . . . . . . . . . . . . . 7
- Historical Perspectives . . . . . . . . . . . . . . . . . . . . 8
- Course Direction:
  - Biology 10 . . . . . . . . . . . . . . . . . . . . . . . 9
  - Biology 20 . . . . . . . . . . . . . . . . . . . . . . . 10
  - Biology 30 . . . . . . . . . . . . . . . . . . . . . . . 12
- Learning Resources . . . . . . . . . . . . . . . . . . . . . . 13

PROGRAM OF STUDIES . . . . . . . . . . . . . . . . . . . . . . . . . 15

- General Goals for Biology 10, 20 and 30 . . . . . . . . . . . . . 17
- Objectives for Biology 10 . . . . . . . . . . . . . . . . . . . 18
- Objectives for Biology 20 . . . . . . . . . . . . . . . . . . . 19
- Objectives for Biology 30 . . . . . . . . . . . . . . . . . . . 19
- Process Skills . . . . . . . . . . . . . . . . . . . . . . . . 20
  - Inquiry Model . . . . . . . . . . . . . . . . . . . . . . 21
  - Process Skills Framework . . . . . . . . . . . . . . . . . 22
- Psychomotor Skills . . . . . . . . . . . . . . . . . . . . . . 28
- Attitudinal Objectives . . . . . . . . . . . . . . . . . . . . 30
- Concepts - Description Statements . . . . . . . . . . . . . . . . 31

CLASSROOM ORGANIZATION . . . . . . . . . . . . . . . . . . . . . . . 53

- Guidelines for Handling of Sensitive Issues . . . . . . . . . . . 55
- Tolerance and Understanding . . . . . . . . . . . . . . . . . . 56
- Student Projects . . . . . . . . . . . . . . . . . . . . . . . 57
- Rationale for Electives . . . . . . . . . . . . . . . . . . . . 58
- Evaluation of Student Progress . . . . . . . . . . . . . . . . . 60
- Uses of Microcomputers . . . . . . . . . . . . . . . . . . . . 61
- The Gifted Student . . . . . . . . . . . . . . . . . . . . . . 62
- Safety in School Laboratories . . . . . . . . . . . . . . . . . 63

APPENDICES . . . . . . . . . . . . . . . . . . . . . . . . . . . . 65

- Appendix A: Controversial Issues . . . . . . . . . . . . . . . . 67
- Appendix B: Experimental Studies . . . . . . . . . . . . . . . . 68

# PHILOSOPHY

The Alberta program for senior high school biology is based on the philosophical premise that fundamental concepts and skill development in the biological sciences should be presented in a context that is environmentally and personally meaningful and relevant to students in interpreting the natural world. It is also premised on a view that accepts the open-endedness of scientific inquiry, and the need for a basic understanding of biological concepts and relationships that characterize the biological sciences. The study of environmental concerns, applications of science and technology, and issues which affect students on a personal and societal basis are also seen as fundamental to a program which must be responsive to current and future needs.

The program accepts the premise that students should be active participants in the learning experience through direct involvement in activities which develop and nurture critical thinking/inquiry skills. Toward this end, the program places a significant emphasis on the development of the scientific inquiry skills and the participation of students in investigative/laboratory activities, projects, field studies and independent research. Students are encouraged not only to assimilate information but to use this knowledge in critically analyzing issues and events which affect them or the environment, from a biological point of view. The development of problem-solving skills is a major goal of the program.

The program also recognizes that students at this level are capable of formal operational thought and recognize the need to challenge them intellectually. Opportunities are provided throughout the program for students to engage in discussion of controversial issues that have influenced the development of biology as a discipline, of science as a way of knowing of developments which influence and advance scientific medical knowledge, and of critical issues that affect the future survival of humankind.

The program is also intended to promote an interest in biology that is not only lifelong, but one that could lead to the pursuit of careers in the field. The program recognizes that students have an intrinsic interest and curiosity about the natural world and about their own biological make-up, which can be capitalized upon and used to encourage further study in the sciences. Attitudes toward the appreciation of living systems, the responsible use of the environment, and biology as a science which influences humankind directly, are important components of the program.

# GENERAL OBJECTIVES FOR SCIENCE EDUCATION

The senior high school biology program is designed to contribute to the achievement of the overall objectives for science in Alberta.

The science program, grades 1-12, in Alberta is designed:

1. To develop the ability to inquire and investigate through the use of science process skills.
2. To promote assimilation of scientific knowledge.
3. To develop attitudes, interests, values, appreciations and adjustments similar to those ideally exhibited by scientists at work.
4. To develop an awareness and understanding of the environment, with positive attitudes and behaviors towards its use.
5. To develop a critical understanding of those current social problems which have a significant scientific component in terms of their causes and/or their solutions.
6. To promote awareness of the humanistic implications of science.
7. To promote an understanding of the role that science has in the development of societies and the impact of society upon science.
8. To contribute to the development of vocational knowledge and skill.

# PROGRAM STRUCTURE AND ORGANIZATION

# PROGRAM ELEMENTS

The biology program is based on four elements: process skills, psychomotor skills, attitudes and concepts (subject matter). The percentage emphasis of each component for instruction in Biology 10, 20 and 30 is listed in the table below. Even though each component is listed separately, instruction should integrate process skills, psychomotor skills and attitudes with the development of concepts. Not all these elements have equal emphasis at each course level. Hence development of these components should take place as the concepts are presented.

| Course<br>Content | Biology 10 | Biology 20 | Biology 30 |
|---|---|---|---|
| Process Skills | 30 | 30 | 20 |
| Psychomotor Skills | 10 | 10 | 5 |
| Attitudes | 10 | 10 | 15 |
| Concepts (Subject Matter) | 50 | 50 | 60 |

## CORE - ELECTIVE FORMAT

The Program of Studies for biology consists of core and elective components, both of which are mandatory for instruction. The core comprises 80 percent of the instructional time with the elective occupying the remaining 20 percent.

Core represents those skills, attitudes and concepts required by all students throughout the province. For further detail please refer to the sections entitled process skills, psychomotor skills, attitudes and concepts in the Program of Studies section of this curriculum guide.

The elective component of the program provides some flexibility in the choice of topics to be studied. This component should reflect the expertise of the teacher or the interests of the students but it should, at the same time, reflect the intent of the respective Biology 10, 20 or 30 course. Suggested elective topics have been listed beside the concept areas stated in the Program of Studies. The emphasis is on issues and applications relative to the concept areas presented. The list is not prescriptive but does provide ideas for teachers from which they may select their elective units.

## CREDIT STRUCTURE

Biology 10 - 3 credits, not less than 62.5 hours of instructional time.

Biology 20 - 3 credits, not less than 62.5 hours of instructional time.

Biology 30 - 5 credits, 125 hours of time for instruction.

## PROGRAM SPECIFICITY

Greater specificity in course content has been promulgated through:

1. Detailed statements concerning general and individual course objectives.
2. Process skill expectations expressed in behavioral terms.
3. Psychomotor skill expectations expressed in terms of manipulating equipment, using tools, carrying out accepted procedures and developing safe practices and procedures.
4. Attitudinal objectives expressed in general and individual course terms.
5. Subject matter expectations expressed as concepts and descriptive statements with percentage emphasis.
6. Comment statements provided to assist in defining the depth and breadth of concepts for presentation.
7. Suggested elective topics expressed in terms of an issue and application emphasis.

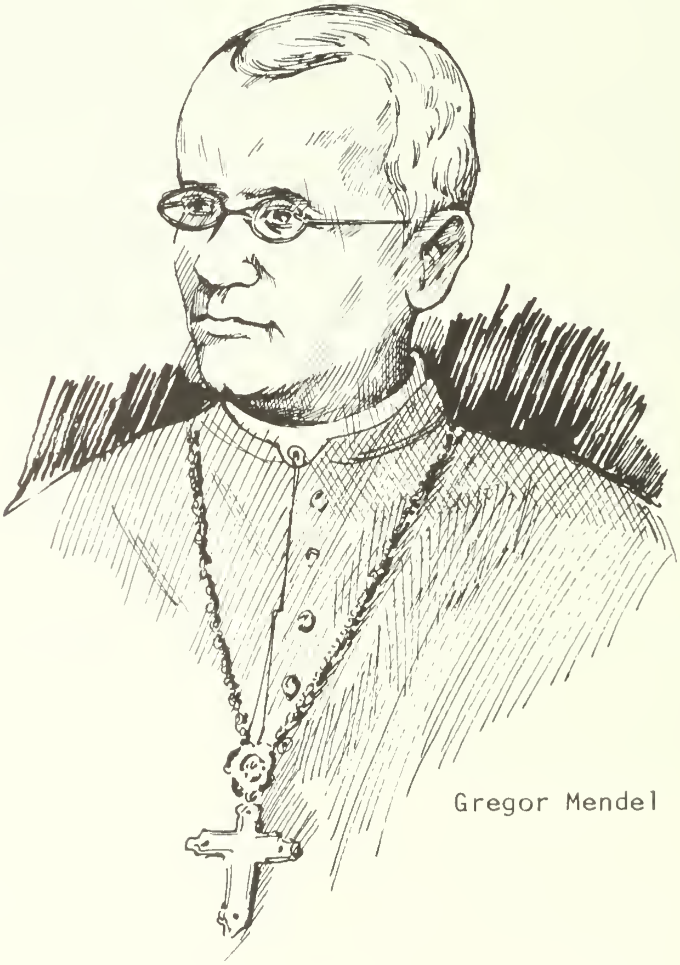
## HISTORICAL PERSPECTIVES

Historical dimensions of biology are important for a broad understanding of scientific developments and their applications leading to the advancement of research in the various biological science fields.

In Biology 10, for example, the contributions of such scientists as Hooke and Leeuwenhoek should be mentioned during discussions of cell theory and the microscope, while Linnaeus must be represented as the individual largely responsible for devising our modern taxonomic system.

The works of Gregor Mendel and Charles Darwin are an integral part of the Biology 20 topics of genetics and speciation.

At the Biology 30 level, reference is made to the research pioneered by scientists, including Canadians such as Banting, Best and Penfield, which led to understandings and treatments of certain disorders and diseases.



Gregor Mendel

# COURSE DIRECTION

## Biology 10

The structure and discussion of cellular function has been limited to those structures as seen through the light microscope. A discussion of cytoplasmic organelles that cannot be seen in the laboratory adds excessive detail and tends to be isolated from the laboratory experience. The mitochondria, as organelles, are better discussed when associated with the processes of cellular respiration. Any discussion of ribosomes should be placed in the context of protein synthesis, where terms like amino acids, nucleotides and nitrogen bases can be dealt with in an organized and unified manner.

The microscope and development of cell theory should provide a historical perspective to the interrelationships between biology and technology, and their influence on society.

Biologists do not always agree on a universally accepted classification system. The intent of the unit on classification is to provide students with the rationale for grouping organisms into taxonomic levels without focusing upon criteria for three, four or five kingdom systems.

The survey of living organisms is intended to provide students entering the biology program with an introduction to the similarities and differences exemplified by various life forms. A study of selected representatives of organisms can be generalized to cover groups of organisms. Extensive and exhaustive studies of particular groups of organisms are not required. The descriptive statements, suggested time allocations and clarification comments provide guidance concerning treatment of core topics. The elective component teaches flexibility in the choice of topics covered based on the needs and interests of students.

## Biology 20

The ecology unit in the biology program is intended to provided an appreciation of the position of life forms and complex interactions of these organisms within the ecosystem. The factual information provided in this section can lead to problem-solving, value clarification and decision-making approaches to the conservation and preservation of the environment.

Because of its importance in supporting other concepts at the Biology 20 level, a general discussion of photosynthesis has been introduced. This discussion brings the process of food production into perspective as the base of the food chain, and makes the information a cornerstone to the evaluation of environmental problems. All too often, ecology has been approached from an animal oriented perspective, thereby creating a limited view of our biosphere and the interactions that occur within it. The concepts of electron transfer, high energy bonds and enzyme reactions should not be included at this level since the students have yet to acquire an adequate background in biochemistry; however, many investigative studies can be pursued. For example, investigations such as how light intensity affects the rate of photosynthesis, the function of chlorophyll in photosynthesis, the effects of light upon starch production in a leaf, and techniques for separating pigments in leaves, can be undertaken.

The impact and influence humans and technology have had on the environment are discussed as issues associated with particular concepts within the course. For example, the issue of acid rain is raised in association with the principles which govern the water cycle. Since these issues are influenced by political, social, cultural, technical and economic factors, the discussions which ensue should place science in a context that is socially and technologically relevant.

Students should be encouraged to become involved with decision-making processes and the evaluation of technical data. By assimilating the principles of the hydrologic cycle and the problems presented by acid rain, the program allows the student to apply factual material to important issues in the world today.

A presentation of the knowledge derived from genetic principles, the structure of DNA and cell division lends itself to an understanding of heredity and change. This can lead to the development of scientific theories which support evolution, and further, which provide insight into recent developments such as those in genetic engineering and biotechnics.

# Biology 30

The Biology 30 course deals with cellular function, biochemistry and physiology; with primary focus on human physiology and function. This approach to an understanding of human systems can be readily applied to other organisms. The study of cellular organelles, control mechanisms, circulation, excretion, nervous and endocrine systems, and reproduction are a few of the applications that should be considered. The emphasis should be on physiology rather than anatomy. The general biological principles which have been identified in the human may be dealt with in respect to in-depth study of lower forms in the elective component.

The program encourages an integrated systems approach to the study of human function. For example, the fundamental principles of kidney function may be related to the cardiovascular system, hormone system, digestion and liver function. By utilizing this approach in the study of the human system, principles inherent in enzyme control, pH, feedback and competitive inhibition can be incorporated. The least preferred approach is one which is based on a presentation of factual knowledge of systems as isolated units working independently of each other. Such approaches stress anatomy, terminology and rote learning.

To be consistent with the goals and interest of the program, an exhaustive or extensive study of biochemistry should not be attempted. The rationale is based on the fact that many students enter the Biology 30 program without any chemistry background. A detailed biochemistry approach to topics such as cellular respiration tends to confuse students with excessive detail at the expense of understanding fundamental ideas associated with the basic differences between aerobic and anaerobic respiration, the idea that oxidation of an organic compound releases energy which can be stored by cells, and the uses of the stored energy. Memorizing the names or chemical structures of intermediary metabolites for oxidative phosphorylation or the Krebs cycle should be avoided.

The curriculum is designed to initiate a movement away from a didactic dissemination of factual information and is intended to redirect instruction toward more relevant utilizations of knowledge. The inclusion of open-ended questions, environmental problems and societal issues in the core and elective components should better enable our students to meet relevant challenges faced by society in the 1980's and beyond.

# LEARNING RESOURCES

## Biology 10 and 20

Prescribed:

Oram, Raymond F., Biology: Living Systems. Merrill, 1983.

Smallwood, William and Peter Alexander, Biology: Living Systems. Silver Burdett, 1983.

Kaskel, Albert et al., Laboratory Biology - Investigating Living Systems. Merrill, 1983.

Recommended:

Otto, James et al., Modern Biology. Holt Rinehart and Winston, 1981.

Kormondy, E.J. and Essenfeld, B.E., Biology: Teacher's Resource Book. Addison Wesley Publishing Company, 1984.

The above texts authorized for provincial use are intended to meet the curricular needs of the Biology 10 and 20 courses. Both textbooks contain more material than is necessary to cover the minimum core component as outlined in the Program of Studies. The laboratory manual approved for prescribed status is self-contained: that is, it may be used with either authorized textbook. A third textbook is included in the recommended list. This book provides good material for enrichment, elective work and further study.

## Biology 30

Prescribed:

Berry, G.S. and Gopaul, H.S., Biology of Ourselves: A Study of Human Biology. John Wiley and Sons, 1982.

Kormondy, E.J. and Essenfeld, B.E., Biology. Addison Wesley Publishing Company, 1984.

Recommended:

Kormondy, E.J. and Essenfeld, B.E., Biology: Teacher's Resource Book. Addison Wesley Publishing Company, 1984.

Both textbooks contain more material than is necessary to cover the core component of the course as outlined in the Program of Studies. The approach in each textbook differs, hence teachers should preview each textbook prior to selecting one for use. Many elective topics related to the program are discussed within each textbook.

# PROGRAM
# OF
# STUDIES

# GENERAL GOALS FOR BIOLOGY 10, 20 AND 30

1. To develop an understanding of the interrelationships of biology and technology, and their influence on society.

2. To develop those attitudes, psychomotor and processs skills, which are associated with scientific inquiry.

3. To develop an interest in biology as a natural science.

4. To develop an awareness of the delicate balance of nature and the appreciation that the survival of all life forms depends upon this balance.

5. To encourage further interest in biological phenomena through the use of electives.

6. To provide a historical perspecive to developments in the biological sciences.

7. To prepare students to make responsible decisions regarding science related social issues.

8. To develop an appreciation of how biologists carry out their work.

9. To make students aware of possible careers in the field of the biological sciences.

# OBJECTIVES FOR BIOLOGY 10

1. To identify the characteristics that distinguish living things from non-living things.
2. To understand the development of cell theory and its application.
3. To understand how organisms can be classified into various levels.
4. To initiate an understanding of the differences and similarities that exist among organisms.
5. To develop effective techniques in the use of microscopes.
6. To develop effective dissecting techniques.

## OBJECTIVES FOR BIOLOGY 20

1. To develop understandings of the interactions and interrelationships between biotic and abiotic factors within communities, ecosystems and biomes.

2. To understand the principles of genetics.

3. To recognize some of the reasons why there is a great diversity among organisms.

4. To examine society's impact on the biosphere.

## OBJECTIVES FOR BIOLOGY 30

1. To examine selected cell structures and functions.

2. To introduce homeostatic mechanisms and the regulation of body systems.

3. To introduce a chemical basis for life.

4. To examine the following human processes:

   a) alimentation and nutritional needs
   b) circulation of body fluids
   c) breathing and gas exchange
   d) cellular respiration
   e) movement and support
   f) regulation of body fluids
   g) nervous and hormonal control systems
   h) reproduction

# PROCESS SKILLS

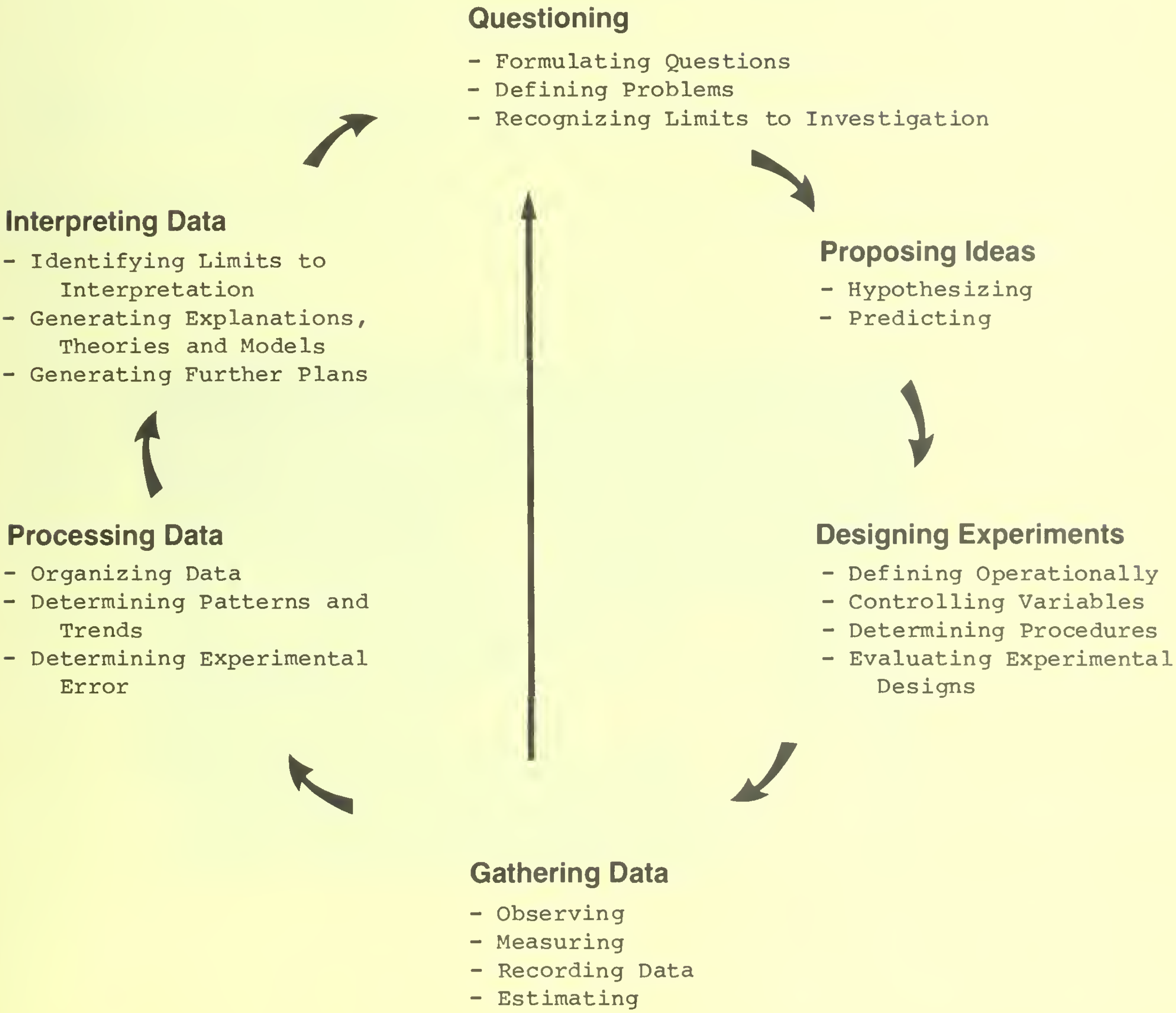
As a science, biology is not only concerned with the product of scientific investigations but is equally concerned with the processes by which scientific investigations take place. The activities which scientists exhibit while doing research or while engaged in problem-solving are commonly referred to as process skills. These are fundamental to the methodology of science. It is appropriate that the biology program provide students with opportunities to develop and refine their competencies in applying process skills through practice.

In providing for the process skill instruction, it is important to recognize that there is no fixed sequence that can be applied universally to all investigations. In actual scientific inquiry the processes that are involved are many and varied, with some skills more critical to some investigations than to others. In teaching the nature of inquiry it is important to give attention not only to the individual steps, but also to create an awareness of the larger cycle of thought and action that we call scientific inquiry.

The following model and framework depicts the major stages of inquiry and the process skills to be taught. Each stage is shown as a small part of an inquiry cycle. Note that although direction arrows are shown to indicate a typical cycle of inquiry, the sequencing of individual stages is not prescriptive. Several of these stages may be of little consequence to a particular investigation and the sequence in which they are followed may vary considerably. The process skills developed within the context of science are not limited to empirical investigations and scientific inquiry, but are transferrable to other areas of research.

# INQUIRY MODEL

The following model depicts six major stages of inquiry and specific process skill statements associated with each stage.



**Questioning**

- Formulating Questions
- Defining Problems
- Recognizing Limits to Investigation

**Proposing Ideas**

- Hypothesizing
- Predicting

**Designing Experiments**

- Defining Operationally
- Controlling Variables
- Determining Procedures
- Evaluating Experimental Designs

**Gathering Data**

- Observing
- Measuring
- Recording Data
- Estimating

**Processing Data**

- Organizing Data
- Determining Patterns and Trends
- Determining Experimental Error

**Interpreting Data**

- Identifying Limits to Interpretation
- Generating Explanations, Theories and Models
- Generating Further Plans

# PROCESS SKILLS FRAMEWORK

Instruction toward the development of the process skills and general understanding of scientific inquiry should include the following outcomes.

## 1. QUESTIONING

### 1.1 Formulating and Expressing Relevant Questions.

1.1.1 perceive discrepant events relative to subject matter studied.

1.1.2 perceive possible relationships between objects, events, properties and/or living things.

1.1.3 express questions about perceived relationships.

### 1.2 Defining Problem Statements.

1.2.1 identify specific variables for study.

1.2.2 state possible relationships between these variables.

1.2.3 distinguish information that is relevant to the problem statement from information that is irrelevant.

### 1.3 Recognizing Limitations to Scientific Investigation of Given Questions and Problems.

1.3.1 recognize assumptions and limitations implied in the phrasing of questions or problem statements.

1.3.2 recognize the limitations of empirical methods as means of answering identified questions.

## 2. PROPOSING IDEAS

2.1 Formulating Hypotheses.

- 2.1.1 describe proposed relationships between variables, referring to known models, theories and other background information where possible.
- 2.1.2 describe possible relationships between variables in quantitative terms where applicable.
- 2.1.3 evaluate hypotheses based on existing knowledge and experience.

2.2 Stating Predictions.

- 2.2.1 predict occurrences and events.
- 2.2.2 make predictions based on interpolation or extrapolation.
- 2.2.3 make predictions based on application of a mathematical formula.

## 3. DESIGNING EXPERIMENTS

### 3.1 Defining Operationally.

3.1.1 construct operational definitions.

3.1.2 distinguish between operational and non-operational definitions.

### 3.2 Identifying and Controlling Variables.

3.2.1 identify manipulated (independent) and responding (dependent) variables.

3.2.2 identify variables to be controlled and devise means for controlling them.

### 3.3 Determining Procedures.

3.3.1 select techniques that are appropriate to the problem and that are safe and ethically sound.

3.3.2 select suitable apparatus.

3.3.3 identify the purpose of each procedure.

3.3.4 determine an appropriate sequence for procedures.

3.3.5 state procedures clearly.

3.3.6 design a suitable format for recording data.

3.3.7 determine the headings to be used within the data recording format.

3.3.8 choose appropriate intervals for the manipulated variable.

3.3.9 determine the sample size.

3.3.10 determine an appropriate number of trials to give a reasonable reliability.

3.3.11 determine reasonable levels of precision for all measures.

### 3.4 Evaluating Experimental Designs and Suggesting Modifications Where Appropriate.

3.4.1 identify variables that are not controlled by the procedures to be used.

3.4.2 identify possible sources of procedural or measurement error.

3.4.3 suggest methods for improving precision of measures used.

3.4.4 identify missing or extraneous steps in an experimental design.

3.4.5 adjust experimental procedures.

# 4. GATHERING DATA

## 4.1 Observing Accurately.

4.1.1 distinguish between observations and inferences.

4.1.2 use specialized observation equipment effectively.

4.1.3 use specialized sampling and manipulative equipment effectively.

## 4.2 Measuring Accurately.

4.2.1 identify the precision of measuring instruments used.

4.2.2 use measuring instruments with skill and precision.

4.2.3 repeat observations and measurements where questionable data arise.

## 4.3 Recording Data Clearly and Completely.

4.3.1 record descriptive observations accurately.

4.3.2 record measurements in a form that expresses the precision of instruments used.

4.3.3 prepare labelled diagrams of objects and materials studied.

## 4.4 Estimating Quantities and Measures.

4.4.1 estimate quantity of objects observed.

4.4.2 estimate measures of objects or events observed.

4.4.3 distinguish between reasonable and unreasonable values for direct and derived measurements.

# 5. PROCESSING DATA

5.1 Organizing and Presenting Data.

5.1.1 classify data into appropriate categories.

5.1.2 design charts or tables for processed data.

5.1.3 select and apply suitable mathematical treatments of data.

5.1.4 indicate units throughout all calculations.

5.1.5 produce suitable graphs.

5.1.6 choose other means of presenting data where appropriate.

5.2 Determining Patterns and Trends in Data.

5.2.1 identify patterns and trends.

5.2.2 produce "best fit" line for graphs.

5.2.3 identify anomalies in data.

5.3 Determining Experimental Error Both for Original Data and for Values Derived from these Data.

5.3.1 use significant digits in expressing experimental results.

5.3.2 calculate the percent error of experimentally determined values (relative to accepted or predicted values).

# 6. INTERPRETING DATA

6.1 Identifying Limits to Interpretations.

- 6.1.1 state limitations affecting interpretation of the data.
- 6.1.2 use language that expresses an appropriate level of certainty/uncertainty in stating interpretations.

6.2 Generating Appropriate Explanations, Theories and/or Models.

- 6.2.1 draw inferences from data.
- 6.2.2 state interpretations within the limits of the experimental design.
- 6.2.3 revise hypotheses in accordance with data collected.
- 6.2.4 generate appropriate explanations, models and/or theories.
- 6.2.5 evaluate alternate explanations, models and/or theories.

6.3 Generating Ideas for Extending Knowledge Related to the Area of Investigation.

- 6.3.1 determine need for extension of the investigation.
- 6.3.2 identify additional questions to investigate.

# PSYCHOMOTOR SKILLS

Psychomotor skills can be regarded as those skills which involve an integration between muscular movement and intellect. A progressive development of many of these skills throughout the high school biology program is important in areas requiring manipulation of materials and apparatus. Safety must be a primary concern during the development of these skills. Because many of the skills are progressive and repeated at the three levels of biology, no attempt was made to assign the skills to any one level.

Due to the flexibility provided by electives and the varied resources of individual schools, the examples provided for the different psychomotor skills is not to be interpreted as a prescriptive list but merely as representative of the psychomotor skills they define.

The students should have the ability to:

1. Manipulate equipment:

    a) Microscope
    b) Bunsen burner
    c) Microcomputers
    d) Centrifuge
    e) Water baths
    f) Hot plates
    g) Balance
    h) Stethoscopes
    i) Sphygmomanometers

2. Use tools:

    a) Develop proficiency in the use of various tools and instruments
    b) Use dissecting instruments
    c) Use common laboratory tools (beakers, tongs, graduated cylinders, etc.)
    d) Use mortar and pestle

3. Carry out accepted procedures:

    a) Preparation of wet and dry mount slides
    b) Develop techniques for the separation of pigments
    c) Staining techniques
    d) Collecting and preserving techniques
    e) Dissecting procedures
    f) Biochemical analysis techniques
    g) Focusing microscopes

4. Develop safe practices and procedures:

    a) Safe use of chemicals in the laboratory
    b) Antiseptic techniques for microbiology
    c) Proper handling of supplies and equipment
    d) Proper handling of living specimens

# ATTITUDINAL OBJECTIVES

## General

1. To promote an appreciation of the interdependencies and interrelationships among biology, technology, and society.

2. To develop an interest in biology as a natural science.

3. To develop an interest and appreciation of the attitudes demonstrated by scientists in their work.

4. To develop a sense of responsibility in decision-making concerning science related social issues.

5. To develop an appreciation of science as an important vocational and intellectual pursuit.

6. To develop an appreciation of the historical development of modern science.

## Biology 10

1. To develop an appreciation of the diversity among living things.

## Biology 20

1. To develop an appreciation of the role humans play in their environment and their dependence upon that environment.

2. To develop an appreciation of the interdependence of living organisms within their environment.

3. To develop positive attitudes and behaviors towards the use of the environment.

## Biology 30

1. To develop an appreciation of the interdependence of human organ systems and their functioning in a homeostatic relationship.

# CONCEPTS - DESCRIPTION STATEMENTS

The order of topics, presented in the following section is suggestive rather than prescriptive. The subject matter reflected in the concept statements should be developed and presented in a sequence that is appropriate and meaningful to the teacher and students. Comments concerning the depth and breadth of the concepts covered are provided where necessary for clarification purposes.

Social issues and environmental concerns should extend and be related to the core concept of the program. Including pertinent and current issues at the time that key concepts are being discussed provides meaning and application to the subject matter. Because social and environmental issues are constantly changing, their presentation should be in keeping with student interest and currency of the issue, both environmentally and socially.

# BIOLOGY 10

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| I. LIVING THINGS ARE COMPOSED OF CELLS.<br>(12 PERCENT)<br>NOTE: THESE TIME PERCENTAGES ARE BASED ON THE 80 PERCENT CORE COMPONENT. | A. THE WORK BY LEEUWENHOEK AND HOOKE RESULTED IN THE DISCOVERY OF MICROSCOPIC LIFE WHICH LED TO THE DEVELOPMENT OF THE CELL THEORY.* | *The time emphasis here allows one to develop the historical dimension of the cell theory and the microscope and to carry out investigations teaching students how to use a microscope proficiently. | The development of the microscope has had an impact on society. |
| | B. SOME CELL STRUCTURES CAN BE VIEWED THROUGH A REGULAR LIGHT MICROSCOPE.**<br>1. EUKARYOTIC CELLS ARE SURROUNDED BY A MEMBRANE ENCLOSING CYTOPLASM AND A NUCLEUS.<br>2. PLANT TYPE CELLS USUALLY INCLUDE A CELL WALL, CHLOROPLASTS AND OFTEN ENLARGED VACUOLES.<br>3. PLANT AND ANIMAL CELLS DISPLAY UNIQUE AND DISTINGUISHING CHARACTERISTICS. | **Only those cellular organelles that can been seen using a light microscope should be introduced at this time. Discussions of additional organelles should occur in context with concepts discussed, e.g., ribosomes with protein synthesis. | |
| | C. MULTICELLULAR ORGANISMS ILLUSTRATE SUCH LEVELS OF ORGANIZATION AS TISSUES, ORGANS AND SYSTEMS. | | |
| II. TAXONOMY IS THE SCIENCE OF CLASSIFYING ORGANISMS.<br>(8 PERCENT) | A. ORGANISMS ARE GROUPED ON THE BASIS OF MORPHOLOGY. | | |
| | B. ORGANISMS MAY ALSO BE GROUPED ON THE BASIS OF OTHER CRITERIA SUCH AS DEGREE OF COMPLEXITY, HABITAT OR NUTRITIONAL REQUIREMENTS. | | |
| | C. LINNAEUS DEVELOPED A SYSTEM OF BINOMIAL NOMENCLATURE. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| | D. DIFFICULTIES HAVE ARISEN IN THE DEVELOPMENT OF A UNIVERSALLY ACCEPTABLE CLASSIFICATION SYSTEM. | | |
| | E. DICHOTOMOUS KEYS ARE A USEFUL TOOL IN CLASSIFYING ORGANISMS. | | |
| III. VIRUSES ARE SUBCELLULAR STRUCTURES. | A. VIRUSES HAVE CHARACTERISITICS OF BOTH THE LIVING AND THE NONLIVING. | | Microorganisms have been developed and tested for use in warfare. |
| (3 PERCENT) | B. VIRUSES REPRODUCE WITHIN A HOST CELL.* | *Only the lytic cycle should be examined. DNA or RNA replication (molecular structures) is not required for this section. | Vaccines and sera are used in disease prevention. |
| | C. SOME DISEASES ARE ASSOCIATED WITH VIRUSES. | | |
| IV. LIFE FORMS MAY EXIST AT THE UNICELLULAR AND THE MULTICELLULAR LEVELS OF ORGANIZATION. | A. BACTERIA ARE CONSIDERED THE MOST PRIMITIVE OF KNOWN LIFE FORMS.<br>1. BACTERIA ARE TYPICAL OF PROKARYOTIC CELLS.<br>2. BACTERIA HAVE SPECIFIC GROWTH REQUIREMENTS. | | History has been influenced by pathogens. (eg.) Black Death, Potato Famine |
| (6 PERCENT--BACTERIA) | 3. BACTERIA ARE OF IMPORTANCE TO OTHER ORGANISMS.<br>4. SOME DISEASES ARE ASSOCIATED WITH BACTERIA. | | The continuous evolution of pathogens results in new forms of disease. |
| (6 PERCENT--UNICELLULAR/COLONIAL) | B. MANY EUKARYOTIC CELLS ARE UNICELLULAR OR COLONIAL.**<br>1. PARAMECIUM IS A REPRESENTATIVE PROTOZOAN.<br>2. SPIROGYRA EXHIBIT THE CHARACTERISTICS OF COLONIAL ALGAE. | **Emphasis should be on the structural rather than the genetic reproduction. This applies to all representative organisms. | Algae are important as a supplier of oxygen and as a potential food source. |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| (5 PERCENT--FUNGI) | C. FUNGI HAVE MANY UNIQUE CHARACTERISTICS. | | |
| | 1. BREAD MOLD EXHIBITS STRUCTURAL AND FUNCTIONAL CHARACTERISTICS OF FUNGI. | | |
| | 2. FUNGI ARE BOTH HARMFUL AND BENEFICIAL. | | |
| (16 PERCENT--PLANTS) | D. MOST PLANTS ARE PHOTOSYNTHETIC, MULTICELLULAR ORGANISMS. | | |
| | 1. MOSSES ARE SUCCESSFUL PLANTS LACKING CONDUCTIVE TISSUE. | | |
| | a) THEY OCCUPY A VARIETY OF HABITATS. | | |
| | b) THEY ARE ECONOMICALLY IMPORTANT AND SIGNIFICANT TO THE FUNCTIONING OF A BIOTIC COMMUNITY. | | |
| | 2. FERNS ARE NONSEED PLANTS WHICH HAVE CONDUCTIVE TISSUE. | | |
| | 3. GYMNOSPERMS ARE NONFLOWERING SEED PLANTS.* | *Identifying, diagramming or memorizing of internal anatomy is not mandatory to the understanding of plant function. | Conservationists are concerned with the reforestation, maintenance and harvesting of the coniferous forest. |
| | a) THEY DISPLAY UNIQUE CHARACTERISTICS SUCH AS NEEDLES, NAKED SEEDS AND CONES. | | |
| | b) THEY ARE OF SIGNIFICANT ECONOMIC IMPORTANCE. | | |
| | 4. ANGIOSPERMS ARE FLOWERING, SEED-PRODUCING PLANTS.* | | Many plants are known to have medicinal properties.<br>(eg.) Foxglove - digitalis<br>Willow - acetylsalicylic acid |
| | a) THEIR CHARACTERISTICS EXEMPLIFY THE MOST ADVANCED PLANT FORM. | | |
| | b) VEGETATIVE PARTS--ROOTS, STEMS AND LEAVES HAVE SPECIFIC FUNCTIONS | | |
| | c) MONOCOTS DIFFER FROM DICOTS IN LEAF VENATION, STEM AND ROOT BRANCHING PATTERNS, SEED STRUCTURE, AND THE NUMBER OF FLOWERING PARTS. | | Many individuals develop allergies to pollen. |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| | d) THE FLOWER CONTAINS THE REPRODUCTIVE ORGANS OF THE PLANT. | | Through grafting, new varieties of trees and fruits have been developed. |
| | e) SEED AND FRUIT PRODUCTION RESULT FROM POLLINATION AND SUCCESSFUL FERTILIZATION.* | *An indepth study of the mechanics of fertilization is not required. | Selective breeding has resulted in improved food products. |
| (12 PERCENT--INVERTEBRATES) | E. ANIMALS ARE MULTICELLULAR ORGANISMS WHICH DEMONSTRATE A PHYLOGENETIC PROGRESSION TOWARDS A GREATER DEVELOPMENTAL COMPLEXITY. | | |
| | 1. PORIFERA AND COELENTERATA HAVE TWO CELL LAYERS. | | Corals are responsible for the formation of reefs and atolls. |
| | a) THEY DEMONSTRATE CELL SPECIALIZATION. | | |
| | b) HYDRA IS A PRIMITIVE COELENTERATE POSSESSING TISSUE AND NEMATOCYSTS. | | |
| | 2. WORMS HAVE THREE CELL LAYERS AND PRIMITIVE ORGAN SYSTEMS. | | Domesticated animals are susceptible to a number of parasitic worms. |
| | a) THE TAPEWORM DEMONSTRATES ADAPTATIONS TO A PARASITIC LIFE-STYLE. | | Humans are host to a variety of parasitic worms. |
| | b) LUMBRICUS (THE EARTHWORM) PROVIDES A REPRESENTATION FOR AN IN-DEPTH STUDY OF ORGAN SYSTEMS. | | |
| | 3. MOLLUSKS AND ECHINODERMS ARE BOTH HARMFUL AND BENEFICIAL TO OTHER ORGANISMS. | | |
| | 4. ARTHROPODS ARE THE LARGEST GROUP OF ANIMALS. | | Beekeeping is a major commerical use of insects in Alberta. |
| | a) THEY SHARE COMMON CHARACTERISTICS. | | Insects are used in biological control of pests. (eg.) Ladybugs. |
| | b) THE CRAYFISH PROVIDES REPRESENTATION FOR AN IN-DEPTH STUDY OF MORE COMPLEX ORGAN SYSTEMS. | | |
| | c) THE SUCCESS OF SPIDERS AND INSECTS CAN BE MEASURED BY THIER DIVERSITY AND ADAPTIONS. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| (12 PERCENT--CHORDATES) | 5. CHORDATES REPRESENT THE MOST COMPLEX ANIMAL GROUP.* | *The general characteristics of each class illustrate progressive complexity in the development of organ systems. | |
| | a) CHORDATES POSSESS A NOTOCHORD, GILL POUCHES AND A DORSAL NERVE CORD. | | |
| | b) FISH ARE A MAJOR GROUP OF PRIMITIVE CHORDATES. | | |
| | c) AMPHIBIANS HAVE CHARACTERISTICS OF BOTH AQUATI AND TERRESTRIAL CHORDATES. THE FROG PROVIDES REPRESENTATION OF AN IN-DEPTH STUDY OF CHORDATE ORGAN SYSTEMS. | | |
| | d) REPTILES DISPLAY CHARACTERISTICS OF THE FIRST TRUE TERRESTRIAL CHORDATES. | | |
| | e) BIRDS DISPLAY CHARACTERISTICS THAT ADAPT THEM FOR FLIGHT. | | Flightless birds have special adaptations. |
| | f) MAMMALS DISPLAY CHARACTERISTICS OF THE HIGHEST LEVEL OF COMPLEXITY. | | Monotremes and marsupials have unique mammalian characteristics. |

# BIOLOGY 20

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| I. ECOLOGY IS THE STUDY OF THE INTERRELATIONSHIPS BETWEEN ORGANISMS AND THEIR ENVIRONMENT.<br>(40 PERCENT) | A. MANY FACTORS ARE INVOLVED IN ECOLOGICAL INTERRELATIONSHIPS.<br>1. BIOTIC FACTORS INVOLVE THE LIVING WORLD.<br>2. ABIOTIC FACTORS INVOLVE THE NON-LIVING WORLD.<br>3. BIOTIC FACTORS AND ABIOTIC FACTORS INTERACT. | | Physical factors such as: light intensity, soil chemistry, and water temperature affect the types of organisms found in microcommunities. |
| (20 PERCENT--INTERRELATIONSHIPS) | a) PHOTOSYNTHESIS PROVIDES BOTH ENERGY AND ORGANIC MATERIALS TO THE BIOTIC WORLD.*<br>(1) CHLOROPHYLL AND ACCESSORY PIGMENTS ABSORB LIGHT ENERGY.<br>(2) LIGHT ENERGY IS CONVERTED INTO CHEMICAL ENERGY.<br>(3) CHEMICAL ENERGY MAY BE UTILIZED IN THE SYNTHESIS OF ORGANIC COMPOUNDS. | *Biochemical detail (oxidation-reduction, electron transfer and specific enzymes) are not required at this level.<br>The intent is to establish food production as the basis of the food chain rather than cover a detailed study of the biochemical processes. These three statements should dictate depth of instruction.<br>Laboratory investigations should be emphasized (see rationale, Biology 20, for examples). | Light intensity and temperature affect the rate of photosynthesis, hence influence food production, e.g., air pollution, water turbidity, and particulate matter affect biomass. |
| | b) THE FLOW OF MATTER THROUGH THE ECOSYSTEM IS CYCLICAL AND MAY BE AFFECTED BY MAN'S ACTIVITIES.<br>(1) CARBON-OXYGEN CYCLE AND THE GREENHOUSE EFFECT.<br>(2) NITROGEN CYCLE AND THE IMPORTANCE OF SOIL BACTERIA.<br>(3) WATER CYCLE AND ACID RAIN. | | Soil quality is affected by: biocides fertilizers, crop rotation and flooding. |
| | c) ENERGY TRANSFER THROUGH THE BIOTIC WORLD IS NON-CYCLICAL. | | Alternate food sources may support increasing populations. |
| | d) FOOD CHAINS, PYRAMIDS AND WEBS MAP THE FLOW OF ENERGY THROUGH THE BIOTIC WORLD. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| | e) THE INTRODUCTION OF HERBICIDES AND PESTICIDES INTO AN ECOSYSTEM HAVE SERIOUS EFFECTS ON FOOD WEBS. | | Many herbicides and pesticides are carcinogenic and/or toxic to humans. These may include the use of agent orange in warfare and the lumber industry; 2,4,5T associated with defects; and, DDT stored in body lipid. |
| (6 PERCENT--POPULATIONS) | B. POPULATIONS ARE COMPOSED OF MANY INDIVIDUALS OF THE SAME SPECIES. | | Many animals in northern latitudes demonstrate population cycles (eg.) Snowshoe Hare, Ruffed Grouse |
| | 1. POPULATIONS ARE DEFINED IN TERMS OF SPACE, TIME AND KIND. | | |
| | 2. POPULATIONS ARE CHARACTERIZED BY EXPONENTIAL GROWTH PATTERNS. | | |
| | 3. LIMITING FACTORS CONTROL POPULATION DENSITY. | | |
| | 4. HUMANS EXEMPLIFY AN OVERPOPULATION PROBLEM WITHIN A CLOSED COMMUNITY. | | |
| (14 PERCENT--COMMUNITIES/ BIOMES) | C. THE BIOSPHERE IS COMPOSED OF COMMUNITIES, ECOSYSTEMS AND BIOMES. | | Forest fires and agriculture affect natural communities. |
| | 1. THE ECOSYSTEM IS THE FUNDAMENTAL UNIT OF THE BIOSPHERE. | | |
| | a) SUCCESSION OCCURS WHEN BIOTIC COMMUNITIES CHANGE OVER TIME TOWARDS A CLIMAX COMMUNITY. | | Urban growth has reduced usable agriculture land. |
| | b) ORGANISMS OCCUPY A SPECIFIC NICHE WITHIN A COMMUNITY. | | |
| | c) MANY HABITATS EXIST WITHIN A COMMUNITY. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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|  | 2. NUTRITIONAL RELATIONSHIPS EXIST WITHIN A COMMUNITY. |  | The introdution of non-indigenous species alters the interrelationships within an ecosystem.<br>(eg.) Starlings, Russian Thistle, European Millfoil, Dutch Elm Disease |
|  | a) SYMBIOSIS INVOLVES INTERACTION BETWEEN ORGANISMS.<br>(i) COMMENSALISM<br>(ii) MUTUALISM<br>(iii) PARASITISM |  |  |
|  | b) PREDATOR-PREY RELATIONSHIPS EXIST IN THE BIOSPHERE. |  |  |
|  | c) COMPETITION OCCURS WITHIN AND BETWEEN SPECIES. |  |  |
|  | d) SAPROPHYTES AND DECOMPOSERS AID IN THE DECOMPOSITION OF ORGANIC MATERIAL. |  |  |
|  | 3. THE BIOSPHERE CONTAINS FRESH WATER ECOSYSTEMS. |  | Our limited fresh water supply is threatened by: thermal pollution, sewage runoffs, and chemical pollutants. |
|  | a) CHANGES IN RUNNING AND STANDING WATER ECOSYSTEMS ARE DEPENDENT ON PHYSICAL FACTORS.* | *Discussion should emphasize how physical factors affect change, rather than a detailed survey of the impact of all physical factors. |  |
|  | b) HUMANS ARE THE MAJOR CONTRIBUTOR TO THE POLLUTION OF FRESH WATER. |  |  |
|  | 4. TERRESTRIAL ECOSYSTEMS ARE STUDIED IN TERMS OF BIOMES. |  | A specific biome could be studied by means of field studies. |
|  | a) CANADIAN BIOMES ARE INFLUENCED BY CLIMATE.** | **An overview of Canadian biomes only. |  |
|  | b) MAJOR BIOMES EXIST IN ALBERTA. |  |  |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| II. GENETICS IS THE STUDY OF THE TRANSMISSION OF CHARACTERISTICS FROM ONE GENERATION TO THE NEXT.<br>(40 PERCENT)<br>(8 PERCENT -- CHROMOSOMES/ MITOSIS/MEIOSIS) | A. CHROMOSOMES CARRY THE HEREDITARY MATERIAL.<br>1. MITOSIS IS A PROCESS OF NUCLEAR REPLICATION DURING ASEXUAL REPRODUCTION.*<br>2. MEIOSIS IS A PROCESS OF GAMETE FORMATION NECESSARY FOR SEXUAL REPRODUCTION.<br>a) DIPLOID CHROMOSOME NUMBER IS REDUCED TO HAPLOID CHROMOSOME NUMBER.<br>b) CYTOPLASMIC DIVISION DIFFERS BETWEEN EGG AND AND SPERM FORMATION.<br>c) ABNORMAL MEIOTIC DIVISION MAY OCCUR. | *Students should not be expected to memorize the details of events in individual phases of mitosis and meiosis, but merely be familiar with the overall sequences during the processes of nuclear replication and nuclear reduction. | Information on cell division and mutation provides a basis for understanding cancer and the process of aging. |
| (2 PERCENT-- PRINCIPLES OF HEREDITY--MENDEL) | B. BASIC PRINCIPLES OF HEREDITY WERE ESTABLISHED BY GREGOR MENDEL. | | |
| (18 PERCENT-- PRINCIPLES OF HEREDITY--TODAY) | C. PRINCIPLES OF HEREDITY ARE BASED UPON PREDICTABLE RESULTS:**<br>1. MONOHYBRID AND DIHYBRID CROSSES.<br>2. CODOMINANCE AND INCOMPLETE DOMINANCE.<br>3. MULTIPLE ALLELES.<br>4. SEX LINKAGE. | **Students should be expected to solve simple problems involving these concepts. | |
| (5 PERCENT--DNA-- GENETIC CODE) | D. DNA IS THE CARRIER OF THE GENETIC CODE.***<br>1. EACH DNA MOLECULE IS UNIQUE BECAUSE OF ITS SEQUENCE OF NITROGEN BASE PAIRS.<br>2. DNA IS CAPABLE OF REPLICATION. | ***It is not required to give specific triplet codes, RNA molecules or protein structures to develop these concepts. | Potentials and risks of genetic engineering can be explored within the following topics: Recombinant DNA, Monoclonal antibodies, Onoclonal genes and cancer, patents on new life forms. |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| | 3. EACH PROTEIN IS UNIQUE DUE TO THE SEQUENCE OF AMINO ACIDS IT CONTAINS. | | |
| | 4. SPECIFIC PROTEINS ARE SYNTHESIZED ACCORDING TO SEQUENCE OF NITROGEN BASE PAIRS IN THE DNA MOLECULE. | | |
| | 5. CELLS AND ORGANISMS EXHIBIT TRAITS DUE TO THEIR SPECIFIC PROTEINS. | | |
| | 6. MUTATIONS ARISE FROM VARIATIONS IN THE DNA OR RNA MOLECULES. | | Man made chemicals cause mutations. (eg.) Thalidomide<br>Radiation and viruses can cause mutations. |
| (7 PERCENT--EVOLUTION) | E. HEREDITARY CHANGES AFFECT THE CHARACTERISTICS OF ORGANISMS IN A POPULATION. | | Both evolution and creation can be discussed to assist in explaining the origins of life on earth. |
| | 1. EARLY BIOLOGISTS SUCH AS LAMARCK AND DARWIN ATTEMPTED TO EXPLAIN CHANGES IN CHARACTERISTICS IN POPULATIONS. | | |
| | 2. ENVIRONMENTAL FACTORS INFLUENCE GENE EXPRESSION. | | |
| | 3. SEVERAL FACTORS INFLUENCE SPECIATION. | | |

# BIOLOGY 30

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| I. CELLULAR PROCESSES ARE FUNDAMENTAL TO LIFE<br>(7 PERCENT) | A. ANIMAL CELLS EXHIBIT COMPLEX STRUCTURE AND FUNCTION.*<br>1. MEMBRANES.<br>2. CYTOPLASM AND NUCLEOPLASM.<br>3. ORGANELLES. | *Specific detail can be discussed in the context of the appropriate body systems. | |
| | B. SUBSTANCES NECESSARY FOR LIFE ARE TRANSPORTED BY PHYSICAL AND CHEMICAL PROCESSES.<br>1. DIFFUSION AND OSMOSIS.<br>2. ACTIVE TRANSPORT.<br>3. ENDOCYTOSIS AND EXOCYTOSIS. | | |
| II. HOMEOSTATIC MECHANISMS REGULATE THE BODY AND ITS SYSTEMS.<br>(3 PERCENT)** | A. NEGATIVE FEEDBACK. | **Discussion here should be a general overview so students focus on the concept of control. | |
| | B. ENZYME ACTION REGULATES CELL METABOLISM. | | Vitamins and minerals assist enzyme activity. |
| | C. COMPETITIVE INHIBITORS INTERFERE WITH ENZYME ACTIVITY. | | Some medicines and poisons are examples of competitive inhibitors. |
| | D. ACIDS, BASES AND BUFFERS.*** | ***Numeric calculations are not required. | |
| III. HUMANS MUST TAKE IN AND PROCESS THE REQUIRED NUTRIENTS FOR ABSORPTION.<br>(13 PERCENT) | A. BASIC ORGANIC AND INORGANIC SUBSTANCES PROVIDE REQUIREMENTS FOR CELL MAINTENANCE AND GROWTH. | | Nutrition can influence behavioral patterns. (eg.) Food additives can induce hyperactivity. |
| | 1. IDENTIFY THE IMPORTANCE OF CARBOHYDRATES, PROTEINS, LIPIDS, NUCLEIC ACIDS, VITAMINS, MINERALS AND WATER. | | Behavioral patterns can influence nutrition. (eg.) Anorexia nervosa |
| | 2. IDENTIFY THE GENERAL STRUCTURAL AND FUNCTIONAL DIFFERENCES BETWEEN CARBOHYDRATES, LIPIDS AND PROTEINS.**** | ****The teaching of specific atomic arrangements is not required. | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| | 3. CARBOHYDRATES, LIPIDS AND PROTEINS CAN BE IDENTIFIED IN THE LAB.<br>a) CARBOHYDRATES (BENEDICT'S SOLUTION AND IODINE).<br>b) LIPIDS (SUDAN IV AND TRANSLUCENCE).<br>c) PROTEINS (BIURET SOLUTION). | | |
| | 4. THE ANATOMY OF THE DIGESTIVE SYSTEM CONSISTS OF THE MOUTH, ESOPHAGUS, STOMACH, SMALL INTESTINE, LARGE INTESTINE AND ANUS. | | |
| | 5. ACCESSORY STRUCTURES WHICH ASSIST IN THE PROCESS OF DIGESTION ARE SALIVARY GLANDS, LIVER, GALL BLADDER AND THE PANCREAS. | | |
| | 6. DIGESTION INCLUDES THE PHYSICAL AND CHEMICAL BREAKDOWN OF INGESTED MACROMOLECULES PREPARING THEM FOR ABSORPTION.<br>a) ORAL (SALIVARY AMYLASE).<br>b) GASTIC (PEPSIN, HC1)<br>c) INTESTINAL (CAROHYDRASES, BILE, LIPASE, BICARBONATE ION). | | Some digestive problems can be solved by taking enzyme supplements. |
| | 7. THE RELEASE OF DIGESTIVE ENZYMES IS UNDER:<br>a) MECHANICAL CONTROL (PERISTALSIS).<br>b) HORMONAL CONTROL (GASTRIN, SECRETIN).<br>c) NERVOUS CONTROL. | | Pavolov's work on digestive enzymes. |
| | 8. NUTRIENTS ARE ABSORBED INTO THE CIRCULATORY SYSTEM. | | |
| | 9. THE LARGE INTESTINE ABSORBS WATER AND VITAMINS, STORES, THEN EJECTS UNDIGESTED MATERIALS. | | The importance of fibre in the digestive system. |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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| | 10. MALFUNCTIONS OF THE DIGESTIVE SYSTEM CAN RESULT IN ULCERS OR GALL STONES.* | *Discussion should be introductory and not in-depth. | |
| | 11. FOREIGN SUBSTANCES MAY BE ABSORBED AND RETAINED BY BODY TISSUE.** | **Discussion should be limited to concepts rather than specific examples. | Many substances such as heavy metals and pesticides may be carcinogenic and/or may interfere with body metabolism. |
| IV. BODY FLUIDS DISTRIBUTE ESSENTIAL NUTRIENTS TO AND CARRY WASTES AWAY FROM TISSUES.<br>(11 PERCENT) | A. THE HEART AND ITS MAJOR BLOOD VESSELS ARE STRUCTURED TO FACILITATE CIRCULATION. | | Heart and lung machines have been developed to facilitate circulation and oxygenation of blood. |
| | B. BLOOD CIRCULATION OCCURS IN A CLOSED SYSTEM CONSISTING OF ARTERIES, ARTERIOLES, CAPILLARIES, VENULES AND VEINS. | | Surgery involving the circulatory system may include bypass surgery, replacement of valves, replacement of major blood vessels and installation of pacemakers. |
| | C. HOMEOSTATIC CONTROLS MAINTAIN CARDIAC OUTPUT AND BLOOD PRESSSURE. | | Prenatal vs. postnatal circulation. |
| | 1. CAPILLARY FLUID EXCHANGE. | | Stress and some environmental factors can lead to circulatory problems such as blood clots, heart attacks, strokes, and high blood pressure. |
| | 2. THE MEDULLA OBLONGATA PROCESSES INFORMATION FROM: | | |
| | a) STRETCH RECEPTORS. | | Disorders affecting blood may include such things as leukemia, hemophilia, mononucleosis and hepatitis. |
| | b) CARBON DIOXIDE. | | |
| | 3. HEART TISSUE IS SELF-STIMULATING. | | C.P.R. - Cardio-pulmonary Resuscitation. |
| | D. BLOOD IS THE PRIMARY CIRCULATING BODY TISSUE FLUID. | | |
| | 1. CELLULAR COMPONENTS HAVE SPECIFIC FUNCTIONS. | | |
| | a) ERYTHROCYTES TRANSPORT GASES. | | |
| | b) LEUCOCYTES CONTROL FOREIGN INVADING BODIES THROUGH ANTIBODY PRODUCTION AND PHAGOCYTOSIS. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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|  | c) PLATELETS INITIATE BLOOD CLOTTING. |  |  |
|  | 2. NONCELLULAR COMPONENTS INCLUDE PLASMA PROTEINS, INORGANIC MOLECULES, NUTRIENTS AND WASTE MOLECULES. |  |  |
|  | 3. SPECIFIC PROTEINS DETERMINE BLOOD TYPES. |  |  |
|  | a) A, B, O FACTORS. |  |  |
|  | b) Rh FACTOR |  | Rh incompatibility may lead to erythroblastosis fetalis. |
|  | 4. OXYGEN CONCENTRATION REGULATES RED BLOOD CELL PRODUCTION. |  |  |
|  | E. MALFUNCTIONS IN THE CIRCULATORY SYSTEM MAY RESULT IN HEART ATTACKS AND STROKES.* | *Discussion should be introductory and not in-depth. |  |
|  | F. LYMPH IS A SECONDARY CIRCULATING BODY FLUID. |  | Blockage of the lymph vessels can result in edema. |
|  | 1. LYMPH SYSTEM. |  |  |
|  | 2. LYMPH FUNCTION. |  |  |
| V. BREATHING PRECEDES GAS EXCHANGE AND TRANSPORT.<br>(6 PERCENT) | A. THE ANATOMY OF THE RESPIRATORY SYSTEM INCLUDES THE: |  | Many environmental pollutants such as smoke, asbestos, nitrous oxides and silicon can cause respiratory diseases. (eg.) Cancer of the lung and emphysema. |
|  | 1. TRACHEA. |  |  |
|  | 2. BRONCHI. |  |  |
|  | 3. BRONCHIOLES. |  |  |
|  | 4. ALVEOLI. |  |  |
|  | B. MECHANICS OF BREATHING INCLUDE: INHALATION AND EXHALATION. |  |  |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
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|  | C. GAS EXCHANGE OCCURS BETWEEN THE ENRIVONMENT, BLOOD AND BODY TISSUES. |  |  |
|  | D. HEMOGLOBIN AND BLOOD PLASMA ARE NECESSARY FOR GAS TRANSPORT. |  |  |
|  | 1. OXYGEN IS TRANSPORTED AS PART OF THE OXY-HEMOGLOBIN MOLECULE. |  |  |
|  | 2. CARBON DIOXIDE IS TRANSPORTED AS PART OF THE BICARBONATE ION, AS PART OF CARBAMINOHEMOGLOBIN AND AS A MOLECULE DISSOLVED IN PLASMA. |  |  |
|  | E. BREATHING RATE IS CONTROLLED BY RESPIRATORY CENTERS IN THE MEDULLA. |  |  |
|  | F. SMOKING CAN ADVERSELY AFFECT THE RESPIRATORY SYSTEM AND MAY RESULT IN:* | *Discussion should be introductory and not in-depth. |  |
|  | 1. LUNG CANCER. |  |  |
|  | 2. EMPHYSEMA. |  |  |
| VI. ENERGY IS RELEASED BY THE OXIDATION OF ORGANIC COMPOUNDS.<br>(4 PERCENT)** | A. CELLULAR RESPIRATION INVOLVES THREE BASIC CONCEPTS. | **Memorization of intermediary metabolites for glycolysis and the Kreb's cycle, as well as the sequence of specific enzymes involved in electron transport, is not required. Exended study in cellular respiration may be undertaken in elective topics. |  |
|  | 1. HYDROGEN AND ITS ELECTRON MOVE FROM WEAK TO PROGRESSIVELY STRONGER ELECTRON ACCEPTORS. |  |  |
|  | 2. THE TRANSFER OF HYDROGEN AND ITS ELECTRON RELEASES ENERGY WHICH CAN BE USED TO FORM HIGH ENERGY BONDS. |  |  |
|  | 3. SOME ENERGY IS STORED AS ATP. |  |  |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
|  | B. ANAEROBIC RESPIRATION IN MUSCLE CELLS: |  |  |
|  | 1. TAKES PLACE IN THE ABSENCE OF OXYGEN. |  | High levels of bicarbonate taken by athletes before events may reduce lactic acid levels and influence performance. |
|  | 2. RESULTS IN THE ACCUMULATION OF LACTIC ACID. |  |  |
|  | 3. PRODUCES LOW AMOUNTS OF ATP. |  |  |
|  | C. AEROBIC RESPIRATION: |  |  |
|  | 1. UTILIZES OXYGEN AS A FINAL ELECTRON ACCEPTOR. |  |  |
|  | 2. RESULTS IN CARBON DIOXIDE AND WATER AS END PRODUCTS. | *Discussion on the quantitive amount of ATP produced is not required. |  |
|  | 3. PRODUCES HIGH AMOUNTS OF ATP.* |  |  |
|  | D. ATP RELEASED DURING CELLULAR RESPIRATION IS UTILIZED FOR SEVERAL METABOLIC PROCESSES INCLUDING: |  |  |
|  | 1. SYNTHESIS. |  |  |
|  | 2. MOVEMENT AND MUSCLE CONTRACTION. |  |  |
|  | 3. HEAT PRODUCTION |  |  |
|  | 4. ACTIVE TRANSPORT. |  |  |
| VII. THE KIDNEY PROVIDES HOMEOSTATIC CONTROL OVER BODY FLUIDS.<br>(8 PERCENT) | A. THE EXCRETORY SYSTEM REMOVES METABOLIC WASTES FROM THE BLOOD. |  | Many ethical questions may be raised in connection with kidney transplants. (eg.) Use of organs from volunteer donors. |
|  | 1. UREA, FORMED IN THE LIVER, IS A MAJOR NITROGENOUS WASTE PRODUCT IN THE BLOOD. |  |  |
|  | 2. THE EXCRETORY SYSTEM INVOLVES THE KIDNEY, URETER, URINARY BLADDER AND URETHRA. |  |  |
|  | 3. URINE FORMATION INVOLVES THE GLOMERULUS, BOWMAN'S CAPSULE, PROXIMAL AND DISTAL CONVOLUTED TUBULES, LOOP OF HENLE, AND COLLECTING DUCT. |  |  |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| | B. BODY FLUID BALANCE IS MAINTAINED BY HORMONES AND IONS. | | |
| | 1. BODY FLUID IS REGULATED BY ALDOSTERONE. | | |
| | 2. OSMOTIC PRESSURE OF BODY FLUIDS IS REGULATED BY ANTIDIURETIC HORMONE. | *Further discussion may include such topics as: bladder infections or kidney stones. | |
| | C. DIALYSIS MAY REPLACE KIDNEY FUNCTION.* | | Advancements in the treatment of kidney diseases include the use of portable dialysis machines. |
| VIII. REGULATION OF INTERNAL ENVIRONMENT REQUIRES COORDINATION BETWEEN THE NERVOUS AND HORMONAL SYSTEMS.<br>(16 PERCENT) | A. ENDOCRINE SECRETIONS REGULATE AND MAINTAIN BODY FUNCTIONS (5 PERCENT). | | |
| | 1. MAJOR ENDOCRINE GLANDS INCLUDE THE PITUITARY, PANCREAS, ADRENAL AND THYROID.** | **Further discussion may include other hormones. | |
| | 2. BLOOD SUGAR REGULATION IS INFLUENCED BY INSULIN, ADRENALIN, THYROXIN AND GLUCAGON. | | Some blood sugar disorders may be treated through proper diet and with hormone supplements. |
| | 3. HORMONE LEVELS ARE REGULATED BY NEGATIVE FEEDBACK.*** | ***Use only the hormones mentioned in VIII.A.2. to discuss this concept. | Hormones may be used to increase and speed the growth of organisms. |
| | 4. DWARFISM IS CAUSED BY A DEFICIENCY IN HUMAN GROWTH HORMONE.**** | ****Discussion should be introductory and not in-depth. | |
| | B. NERVOUS CONTROL INVOLVES RECEPTION, TRANSMISSION, INTERPRETATION AND RESPONSE (11 PERCENT). | | |
| | 1. STIMULI IN THE ENVIRONMENT MUST FIRST BE DETECTED BY SENSORY RECEPTORS. | | |
| | a) EYE. | | Eye defects may be repaired through cornea transplants, cataract removal, and the reattachment of retinas using lasers. |
| | (1) THE CORNEA, IRIS, PUPIL, LENS AND RETINA ARE INVOLVED IN IMAGE FORMATION. | | |
| | (2) LIGHT ACTIVATES RODS AND CONES. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
|  | (3) THE OPTIC NERVE TRANSMITS IMAGES FROM THE RETINA TO THE BRAIN. |  | Various types of lenses may be used to correct such eye defects as nearsightedness, farsightedness, and astigmatism. |
|  | (4) FAR AND NEAR SIGHTEDNESS AND ASTIGMATISM ARE COMMON DISORDERS OF THE EYE. |  | Contact lenses can be both beneficial and harmful. |
|  | b) EAR. |  | Some hearing defects can be overcome using devices such as hearing aids. Others may be treated by replacing defective parts such as the malleus, incus, and stapes. |
|  | (1) THE EARDRUM, OSSICLES, ROUND AND OVAL WINDOWS, COCHLEAR FLUID, AND THE ORGAN OF CORTI ARE INVOLVED IN SOUND TRANSMISSION. |  |  |
|  | (2) THE AUDITORY NERVE TRANSMITS IMPULSES FROM THE COCHLEA TO THE BRAIN. |  | Noise pollution can cause permanent hearing impairment. |
|  | (3) THE EUSTACHIAN TUBE MAINTAINS EQUAL PRESSURE ON BOTH SIDES OF THE EARDRUM. |  |  |
|  | (4) THE SEMICIRCULAR CANALS DETECT BODY POSITION AND MOTION. |  |  |
|  | c) CHEMORECEPTORS DETECT TASTE AND ODOR. |  |  |
|  | d) RECEPTORS IN THE SKIN DETECT PRESSURE AND TEMPERATURE. |  |  |
|  | 2. NEURAL TRANSMISSION RELAYS INFORMATION THROUGHOUT AN ORGANISM. |  | Microsurgery may be used to repair severed nerves. |
|  | a) STRUCTURE OF A NEURON. |  |  |
|  | b) ELECTRICAL ACTIVITY OF A NERVE IMPULSE. |  |  |
|  | (1) THRESHOLD LEVELS. |  |  |
|  | (2) "ALL OR NONE" RESPONSE. |  |  |
|  | (3) REFRACTORY PERIOD. |  |  |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| | c) CHEMICAL TRANSMISSION BETWEEN NEURONS INVOLVES EXCITATORY AND INHIBITORY SUBSTANCES.<br>(1) ACETYLCHOLINE.<br>(2) NORADRENALINE.<br>(3) ACETYLCHOLINESTERASE. | | Substances such as mercury compounds, malathion, and nerve gas may disrupt neural transmission. |
| | 3. THE CENTRAL NERVOUS SYSTEM INTERPRETS INFORMATION AND COORDINATES RESPONSE. | | |
| | a) THE CEREBRUM, HYPOTHALAMUS, CEREBELLUM AND MEDULLA OBLONGATA ARE MAJOR REGIONS OF THE BRAIN. | | Pain may be controlled by naturally produced substances such as endorphins and by artificially produced chemicals. |
| | b) THE SPINAL CORD TRANSMITS INFORMATION TO AND FROM THE BRAIN. | | Phantom pain often accompanies loss of limbs. |
| | c) THE REFLEX ARC INVOLVES PERIPHERAL NERVES AND THE SPINAL CORD. | | |
| | 4. THE AUTONOMIC NERVOUS SYSTEM INVOLVES BOTH SYMPATHETIC AND PARASYMPATHETIC NERVES. | | |
| IX. VOLUNTARY MOVEMENT AND BODY SUPPORT ARE THE RESULT OF SKELETAL MUSCLES AND THE SKELETONS TO WHICH THEY ARE ATTACHED.<br>(4 PERCENT) | A. THE SKELETON PROVIDES FOR MUSCLE ATTACHMENT, PROTECTION OF INTERNAL ORGANS AND LOCOMOTION.*<br>1. LIGAMENTS.<br>2. TENDONS.<br>3. JOINTS. | *Specific names of bones, ligaments, tendons and joints are not required. | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| | B. SKELETAL MUSCLES HAVE A UNIQUE STRUCTURE.<br>1. FIBERS AND FIBRILS.<br>2. ACTIN AND MYOSIN. | | Muscular dystrophy is a hereditary disease which affects neuromuscular transmission. |
| | C. MUSCLE CONTRACTION IS STIMULATED BY NERVE ACTION.* | *Electrochemical discussion is not required. | Further discussion could be based on athletic injuries. |
| | D. MUSCLE CONTRACTION REQUIRES CALCIUM, CREATINE PHOSPHATE AND ATP. | | |
| | E. INFLAMMATION OF THE JOINTS MAY RESULT IN ARTHRITIS.** | **Discussion should be introductory and not in-depth. | |
| X. HUMANS ARE CAPABLE OF REPRODUCING.<br>(8 PERCENT) | A. REPRODUCTION SYSTEMS:<br>1. THE MALE REPRODUCTIVE SYSTEM INVOLVES THE PENIS, SCROTUM, TESTICLES, VAS DEFERENS, URETHRA, POSTRATE GLAND, COWPER'S GLAND AND THE SEMINAL VESSICLE.<br>2. THE FEMALE REPRODUCTIVE SYSTEM INVOLVES THE VAGINA, UTERUS, CERVIX, FALLOPIAN TUBES AND OVARIES. | | |
| | B. THE DEVELOPMENT AND FUNCTIONING OF THE REPRODUCTIVE SYSTEM IS UNDER THE CONTROL OF HORMONES.<br>1. GONADOTROPIC HORMONES REGULATE THE PRODUCTION OF SEX HORMONES.<br>a) FOLLICLE STIMULATING HORMONE.<br>b) LUTENIZING HORMONE<br>c) INTERSTICIAL CELL STIMULATING HORMONE (MALE PRECURSOR)<br>2. TESTOSTERONE FUNCTIONS IN DEVELOPING PRIMARY AND SECONDARY SEX CHARACTERISTICS. | | |

| CONCEPTS | DESCRIPTIVE STATEMENTS | COMMENTS | SUGGESTED ELECTIVE TOPICS: ISSUES AND APPLICATIONS |
|---|---|---|---|
| | 3. ESTROGEN AND PROGESTERONE FUNCTION IN:<br>a) DEVELOPING PRIMARY AND SECONDARY SEX CHARACTERISTICS.<br>b) MENSTRUAL CYCLE. | | |
| | C. PREGNANCY AND CHILD BIRTH:*<br>1. FERTILIZATION AND IMPLANTATION. | *Detailed discussion of embryonic and fetal development is elective material. | Socially transmitted diseases such as syphilis, gonorrhea, herpes and AIDS are of increasing concern. |
| | 2. PREGNANCY IS MAINTAINED THROUGH A HORMONAL BALANCE. | | Technological advances such as in vitro fertilization presents alternatives to natural fertilization. |
| | 3. EMBRYONIC AND FETAL DEVELOPMENT INVOLVES A PLACENTA, THE AMNION, CHORION AND THE UMBILICAL CORD. | | Pre-natal development may be monitored using ultra-sound and amniocentesis. |
| | 4. OXYTOCIN AND RELAXIN ARE INVOLVED IN THE BIRTH PROCESS. | | A mother's lifestyle may effect embryonic development.<br>consumption of alcohol or drugs, dietary patterns, smoking |

# CLASSROOM
# ORGANIZATION

# GUIDELINES FOR HANDLING OF SENSITIVE ISSUES

The presentation of potentially sensitive issues and topics shall be in accordance with Alberta Education policy regarding controversial issues in the classroom (see Appendix A). The intent of the policy statement is to provide for the development of students' capacities to reason logically through divergent and convergent thinking, and to examine critically the issues from several, frequently opposing, points of view. Of course, not all points of view can be studied in detail or even presented. However, opposing positions may be expanded upon in order to promote critical thinking as it relates to the interpretation of issues. To encourage such experiences, care should be taken that neither theories nor beliefs are presented as dogma. Because sensitivity to an issue is apt to vary between and within school districts, it is unlikely that any list of controversial issues would be complete or relevant to all situations. Issues within the biology program requiring attention in this regard include those that relate to population problems (birth control), acid rain, evolution-creation, nuclear energy uses, genetic manipulation and bioethics.

The identification and study of particular controversial issues/topics for classroom study should take into consideration the following:

- Is the issue appropriate for the level and ability of the student group? Considerations must include cognitive, social, moral and physical development of students as well as their prior background and experience.

- Is the issue important in society? Issues that are identified for discussion must be important in terms of social, economic and political problems facing our society, or are seen as possible future concerns.

- Will study of the issue contribute, directly or indirectly to the goals of the program?

- Are there adequate resources available to present a balanced perspective of the issue? Balance is possible only when the resources fairly and adequately present each major or competing position.

- Can the issue be considered within reasonable limits, given available classroom time?

- Does the presentation reflect professional treatment of the issue in terms of school jurisdiction policy, the views of the community, and develops respect, tolerance and understanding of others.

# TOLERANCE AND UNDERSTANDING

A purpose of the senior high school biology program is to allow teachers to develop, with their students, aspects of critical thinking, such as differentiating fact from opinion and withholding judgements, while maintaining an appreciation of the opinions and beliefs of other people. The program encourages the development of positive attitudes, tolerance, understanding, and respect. Sensitive issues, as previously discussed, must be presented free from bias and prejudice concerning age, sex, race, religion or handicap. The presentation of controversial topics must not misrepresent or demean individuals or groups of individuals but should contribute to tolerance, understanding and respect for others.

# STUDENT PROJECTS

Projects provide an opportunity for students to engage in independent study while developing their investigative skills. The student project should be incorporated as a teaching strategy rather than as a separate unit in the course. This strategy may be utilized in either or both the core or elective components. The approach allows students to study a course component independently, in small groups or as a class.

Instructional strategies will vary considerably, and should reflect student interests, and the availability of supplies, equipment and school facilities. Project work should allow students to develop research skills to organize and present reports, or to carry out investigative studies.

# RATIONALE FOR ELECTIVES

The elective component of the biology program is a compulsory section of the course where teachers have flexibility in determining topics to be studied. The topics covered should be related to the intent of the respective course in that they should be based on the overall objectives for that program. Elective topics may be implemented on a periodic basis.

The use of electives should be directed toward a greater understanding of the scientific method through the development of laboratory and library research skills. Electives may be pursued utilizing several instructional strategies ranging from individual to group work and from structured to open-ended investigations. Electives should be designed to make science more interesting and meaningful through the assimilation of current issues and applications of biology.

The elective section of the biology program may be approached in several ways:

1. As an extension of concepts related to core topics.

This is not meant to be an in-depth study of core material, but rather an opportunity to apply and extend core principles to contemporary issues and topics. Some examples are the study of parasitology, contemporary diseases, genetic engineering, nutritional patterns, chemical health hazards, cardiopulmonary resuscitation, influence of the development of the microscope on society, and dichotomous keys.

2. Through the use of scientific reports, periodicals or journals.

Periodicals present interesting discussions of current scientific issues and applications. These articles convey innovative research and technological development and are natural extensions of the biological sciences or sciences generally that have appeal to students.

Scientific papers also provide the science student with an opportunity to evaluate scientific procedures ranging from the identification of problems in experimental design to the critical analysis of data. Students may study external factors influencing research such as funding, finding qualified personnel, and government influence. It should be noted that this approach to elective study will develop an appreciation for the scientist, and reinforce an awareness of scientific differences as well as increase scientific literacy.

Suggested references could include Canadian Geographic, Discover, Equinox, Nature Canada, Science Digest, Science 83, 84, 85..., and Science World.

3. Locally developed units.

Environmental issues specific to geographic areas should be considered. The choice of issue must relate to concepts of the biology program. Examples of such units could include acid rain, the greenhouse effect, land use, winter ecology, and urban planning or pond studies.

# EVALUATION OF STUDENT PROGRESS

Student evaluation should incorporate a variety of assessment techniques. It should not be based only on written examinations, but should include student effort, notes, oral and/or written reports. These approaches to evaluating student performance provide teachers with opportunities to assess students' creativity, understanding, attitudes, psychomotor skills and personal growth. Laboratory activities could be part of the program and should be evaluated by laboratory write-ups, practical tests, written quizzes and the students participation and effort during the activity.

Tests and assignments should utilize a variety of different types of questions. These would include multiple-choice items, matching questions, open-ended questions and essays. All three taxonomic levels of questions (knowledge, application and understanding, and higher mental process) should be considered when developing questions.

# USES OF MICROCOMPUTERS

The use of the microcomputer offers alternative strategies to teaching that provide increased flexibility and scope in dealing with either core or elective material. The successful implementation of software is primarily dependent upon the suitability of the disk, and the organization of the physical setting.

The microcomputer can be utilized in the following ways:

a) Systems Analysis and Simulations

Simulations can provide students with realistic, vicarious experiences of real bio-societal systems. Such simulations allow students to choose different alternatives in such a system. An example would include the simulation of world food production, the mechanisms of gene mutation, or strategies used for weed and insect control.

b) Information Retrieval

Gathered experimental data can be stored and retrieved for later use: for example, air pollution monitoring readings can be stored on disk; $SO_2$ readings could be compared in different areas and during different seasons or years. Another example could be to pool vegetation plot data on disk for comparisons throughout a number of years. The latter data could become assimilated into a succession study.

c) Recording and Processing Data

The computer can provide an invaluable resource in the statistical manipulation of data. Mathematic modelling of biological phenomena such as that illustrated by population growth systems can be organized and presented by graphing techniques, and calculations of population density.

d) Course Review

The microcomputer can provide and organize unit reviews for students in a manner that provides immediate feedback and diagnosis of a student's weaknesses within the area. Most of the course review programs are organized in a drill and practice format, although some other modes do exist. A successful drill and practice style of review should include a tutorial branch for incorrect answers, and thereby incorporate a maximum amount of student interaction.

# THE GIFTED STUDENT

Although in certain schools there are special classes or programs for "gifted" students, the teacher of the mainstream biology program deals, on a daily basis, with many students who exhibit characteristics which are commonly attributed to the "gifted". As the curriculum is presented to the class, opportunities must be left open so that the widest possible range of teaching and learning strategies may be employed in order to serve the needs of the gifted and talented student.

One of the major aims in the education of the gifted student is to develop their research, deductive and creative thinking skills. One strategy for fostering these skills would be to provide opportunities for students to plan and carry out independent projects either inside or outside of the classroom or school. Regular programming may have to be adjusted to compensate for any time where the student is absent from the regular classroom.

Resource personnel from the community might be brought into the school for lectures or seminars, or students might be afforded the opportunity to visit or interview personnel who work in their areas of interest. In this "mentor" approach, gifted students might spend time in a work experience type situation outside of the school under the direction of individuals in a specific field of interest.

Gifted students should be encouraged to participate in such activities as science clubs or school fairs. Their involvement would allow students to develop their interests independently and allow them to compare their efforts with their peers. Also, participation at local, provincial and federal levels will expand students' background experience.

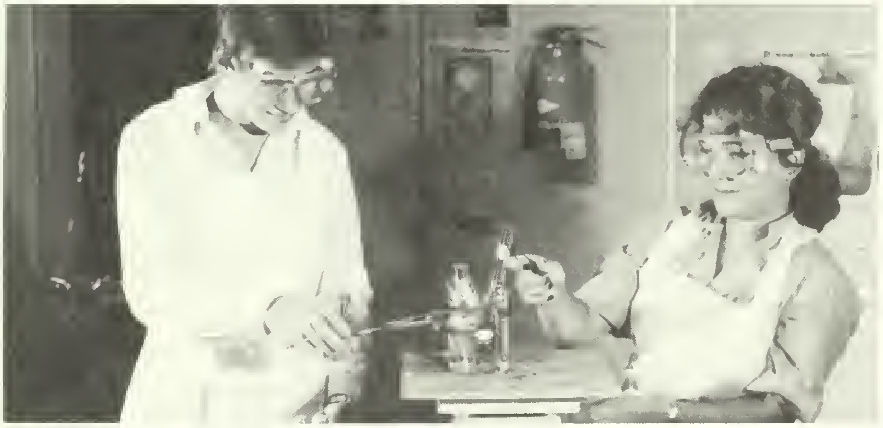
Attendance at conferences is another activity students of this calibre should be encouraged to participate in. Often there are local programs which may lead to extension of core topics within the biology curriculum. These include extension programs offered at museums, technical schools, and science centres.

# SAFETY IN SCHOOL LABORATORIES

Injuries and accidents in school laboratories can be prevented, or at least minimized by:

1. Providing safe school facilities and equipment and limiting class size to numbers which the facility can handle.
2. Becoming familiar with school safety equipment such as fire extinguishers, fire blankets, showers and eye wash stations.
3. Providing access to a well-equipped first aid kit.
4. Making students aware of safe procedures in laboratory activities.
5. Establishing policies, guidelines and routines which govern storage, handling and disposal.

Teachers must familiarize themselves with the proper use and maintenance of equipment and handling of chemicals which are available in their school. They must become aware of potential hazards associated with the use of microwave ovens, autoclaves, centrifuges, corrosive chemicals, toxic substances, inflammable materials, volatile liquids, radioactive materials and carcinogens.



Some laboratory investigations require the use of potentially hazardous chemicals. For example, concentrated acids may be required during laboratory investigations or in preparation of necessary solutions. Concentrated acids are frequently corrosive, poisonous irritants and should be handled carefully. If concentrated acids are placed in dropping bottles for students use, use plastic rather than rubber bulb droppers. Laboratories should contain only those quantities of concentrated acids which would be sufficient for one year's requirements. Iodine stains and solutions are commonly used in laboratory investigations. Prepared iodine solutions should be purchased from the chemical supply houses since crystalline iodine vapor is toxic or extremely irritating and its dust is hazardous when inhaled or touched.

Certain biological investigations require the use of solvents containing ether. Such solvents are highly flammable and extremely explosive. Petroleum ether should be used in lieu of other ethers.

Proper storage facilities must be provided for all potentially dangerous substances. Teachers should refer to the Potentially Hazardous Chemicals Information Guide for the procedure regarding storage, use, dangers and disposal of various chemicals. Other safety manuals should be available to teachers and students.

Guiding principles should be in place to ensure that adequate safeguards exist for the proper care and use of living organisms for experimentation purposes. Lower orders of organisms are preferable subjects for experimentation.

For further information on experimental studies see Appendix B.

If living organisms are kept in the classroom, common sense precautions would keep incidence of allergies and diseases to a minimum. For example, a careful selection must be made of organisms such as nonpathogenic bacteria, healthy plants and animals, nontoxic plants, and molds which are considered safe to handle. Culturing pathogenic organisms in a laboratory voluntarily or by accident must be avoided. For example, some strains of Escherichia coli may cause illness and live outside the culture. Only those strains which cannot live outside nutrient culture media should be used. Contact biological supply houses for safe strains of Escherichia coli. Glassware, incubators and inoculating loops must be kept clean at all times.

Preserved specimens used for dissection or observation must be collected properly, handled carefully, and disposed of without causing infection or contamination. Special care must be taken in collection and disposing of blood, urine or epidermal cells. Teachers should also be aware of students with special health problems which may restrict their participation in certain laboratory activities.

Basic greenhouse precautions must include such practices as selecting only healthy, "safe" plants which are free of parasites. If an infection does take place and the greenhouse has to be sterilized, extreme care must be taken in selecting a noncarcinogenic herbicide and pesticide.

School boards, along with school administrators, should set up jurisdictional policies relating to accidents and insurance. Within the framework of the jurisdictional policies, high school science teachers in consultation with the school's administrators should develop science safety guidelines and procedures for their school. Teachers must be aware of the implications of these policies, guidelines and procedures.

# APPENDICES

# APPENDIX A

Alberta
EDUCATION

## CONTROVERSIAL ISSUES

In August, 1972, The Minister of Education announced a policy regarding controversial issues. This announcement was in response to representations having been made regarding the treatment in school programs of such matters as Canadian content, family life education, sex-stereotyping and special creation, to name a few. By way of interpretation the policy is to be treated as a whole: that is, no clause is to be applied in isolation of any other clause or clauses. The policy is intended to accomplish the following in the handling of issues such as those mentioned above.

1. Provincially it will:
   (a) guide the development and revision of Programs of Study, including the acquisition of support materials.
   (b) serve as the Department of Education position in cases in which the Department may be consulted regarding controversial issues.
2. Locally, the statement is to serve as a guide for the development of policy at system, district or school levels, according to local choice.

### DEPARTMENT OF EDUCATION POLICY
### Re: Controversial Issues in the Classroom

I. In principle, it is an objective of the Alberta educational system to develop students' capacities to think clearly, reason logically, examine all issues and reach sound judgments.

II. The specific policy, based on this principle, is:

1. Students in Alberta classrooms should not be ridiculed or embarrassed for positions which they hold on any issue, a requirement which calls for sensitivity on the part of teachers, students and other participants in dealing with such issues.
2. Students should have experiences in selecting and organizing information in order to draw intelligent conclusions from it. For sound judgments to be made, information regarding controversial issues should:
   (a) represent alternative points of view,
   (b) appropriately reflect the maturity, capabilities and educational needs of the students and reflect the requirements of the course as stated in the Program of Studies,
   (c) reflect the neighborhood and community in which the school is located, but not to the exclusion of provincial, national and international contexts.
3. School trustees should establish, in consultation with appropriate interest groups, policies regarding:
   (a) identification of controversial issues,
   (b) treatment of such issues in local classrooms.
4. Students, teachers and administrative staff should have a voice in determining:
   (a) the controversial issues to be studied,
   (b) the texts and other materials to be used,
   (c) the manner in which such issues are dealt with in the classroom.

In response to representations regarding the treatment of the theory of evolution in school science programs, the Science Curriculum Coordinating Committee prepared and presented the following policy statement to the Curriculum Policies Board. This statement, which interprets the Department's policy regarding controversial issues in relation to science programs in the classroom, was considered by the Curriculum Policies Board in March, 1979, and was accepted by the Minister of Education in June, 1979.

*(a) That where relevant, official curriculum documents published by Alberta Education for use by science teachers should contain:*

*(i) the Department of Education policy statement on controversial issues.*

*(ii) a special statement alerting teachers to the need for sensitivity in handling such issues.*

*(iii) a listing of available learning resources from which school boards, teachers, and/or students may select items representing alternative points of view on such controversial issues as may be included in a Program of Studies.*

*(b) That, at the provincial level, all science curriculum committees and/or individuals associated with selecting, recommending, listing and/or prescribing texts and/or other learning resources for use in Alberta schools be directed to:*

*(i) confine their choice to those learning resources in which the science subject matter is deemed to be satisfactory in terms of the definition of science:*

Natural Science is a branch of knowledge obtained by the scientific method, which deals with a body of observable and reproducible facts concerning material phenomena, systematically arranged and showing the operation of general laws and theories.

*(ii) select learning resouces that are satisfactory in terms of scientific accuracy, adequacy of treatment, and reading level.*

*(iii) recommend the development of such additional materials as may be deemed necessary. (To be used only as a last resort.)*

*(c) That, in the initial selection stage, the inclusion or exclusion of science subject matter in Alberta school science curricula be determined by validating it according to the definition of 'Natural Science' in (b), (i) above.*

# APPENDIX B

## EXPERIMENTAL STUDIES

1. The use of plants and animals must comply with existing local, provincial and federal legislation.

2. All experiments should be carried out under the supervision of a competent science teacher. It is the responsibility of the qualified science teacher to ensure the student has the necessary comprehension for the study to be undertaken.

3. All organisms used in teaching programs must be properly cared for. Consideration should be given to:

   a. proper housing and space.
   b. proper lighting and temperature requirements.
   c. adequate ventilation.
   d. adequate water and food with proper nutritional requirements.
   e. provisions for sanitation.

4. All students carrying out projects involving vertebrate animals must adhere to the following guidelines:

   a. students should not be allowed to take animals home to carry out experimental studies. All studies involving animals must be carried out in a suitable area in the school.

   b. no experimental procedures shall be attempted on a vertebrate animal that should subject it to pain or distinct discomfort, or interfere with its health.

   c. students shall not perform surgery on vertebrate animals.

   d. experimental procedures shall not involve the use of:

      i. microorganisms which can cause disease in man or animals.
      ii. ionizing radiation.
      iii. cancer producing agents.
      iv. drugs or chemicals at toxic levels.
      v. alcohol in any form.
      vi. drugs that may produce pain.
      vii. drugs known to produce adverse reactions, side effects, or capable of producing birth deformities.

   e. experimental treatments should not include electric shock, exercise until exhaustion, or other distressing stimuli.

f. the use of anaesthetic agents, by students is not encouraged and in the case of some anaesthetics is not permitted by law.

g. behavioral studies should use only reward (positive reinforcement) and not punishment in training programs.

h. if egg embryos are subjected to experimental manipulations, the embryo must be destroyed humanely two days prior to hatching. If normal egg embryos are to be hatched, satisfactory humane considerations must be made for disposal of the young birds.

i. all animals must be disposed of in a humane manner. If euthanasia has to be carried out, an approved humane method must be used and performed by an adult experienced in the use of such procedures.

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